AD_____

Award Number: DAMD17-99-1-9326

TITLE: 99-Technetium Sestamibi Scanning to Predict the Efficacy of Estramustine Phosphate in Overcoming Paclitaxel Resistance in Patients with Advanced Breast Cancer

PRINCIPAL INVESTIGATOR: Matthew D. Volm, M.D.

CONTRACTING ORGANIZATION: New York University School of Medicine
New York, New York 10016

REPORT DATE: September 2004

TYPE OF REPORT: Final

PREPARED FOR: U.S. Army Medical Research and Materiel Command
Fort Detrick, Maryland 21702-5012

# REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 074-0188



| 1. AGENCY USE ONLY (Leave blank) | 2. REPORT DATE | 3. REPORT TYPE AND DATES COVERED |
|---|---|---|
| | September 2004 | Final (1 Sep 1999 - 31 Aug 2004) |

**4. TITLE AND SUBTITLE**
99-Technetium Sestamibi Scanning to Predict the Efficacy of Estramustine Phosphate in Overcoming Paclitaxel Resistance in Patients with Advanced Breast Cancer

**5. FUNDING NUMBERS**
DAMD17-99-1-9326

**6. AUTHOR(S)**
Matthew D. Volm, M.D.

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**
New York University School of Medicine
New York, New York 10016

*E-Mail:* Matthew.volm@med.nyu.edu

**8. PERFORMING ORGANIZATION REPORT NUMBER**

**9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)**
U.S. Army Medical Research and Materiel Command
Fort Detrick, Maryland 21702-5012

**10. SPONSORING / MONITORING AGENCY REPORT NUMBER**

**11. SUPPLEMENTARY NOTES**

**12a. DISTRIBUTION / AVAILABILITY STATEMENT**
Approved for Public Release; Distribution Unlimited

**12b. DISTRIBUTION CODE**

**13. ABSTRACT (Maximum 200 Words)**

This research was to investigate the ability of 99-Technetium Sestamibi (Tc-99-SM) to serve as a non-invasive means of assessing the presence of clinically relevant drug resistance in patients with advanced breast cancer. Tc-99-SM is a substrate of p-glycoprotein (P-gp), the transmembrane drug efflux transporter involved in classic multi-drug resistance (MDR). We hypothesized that that rapid clearance of Tc-99-SM correlates with the presence of functional multi-drug resistance and can be used to predict which patients will have tumors resistant to drugs that are MDR substrates. We demonstrated marked variability in the tumor clearance of Tc-99-SM among patients. The second stage of our work was to conduct a clinical trial to determine whether changes in 99-Tc-SM clearance following the administration of an MDR inhibitor could predict effectiveness of the inhibitor in overcoming drug resistance. We met with difficulty in obtaining an MDR inhibitor appropriate for use in the study, as recent studies cast doubt on the ability of estramustine to reverse MDR, and biricodar, our second choice, was discontinued by the manufacturer. Based on compelling laboratory evidence that ZD1839 was a potent inhibitor of MDR, we therefore rewrote the clinical protocol to reflect the use of ZD1839 as the MDR reversing agent. However, we encountered difficulties in procuring drug and in the development of the protocol and no reportable outcomes were realized.

| 14. SUBJECT TERMS | 15. NUMBER OF PAGES |
|---|---|
| breast cancer | 6 |
| | 16. PRICE CODE |

| 17. SECURITY CLASSIFICATION OF REPORT | 18. SECURITY CLASSIFICATION OF THIS PAGE | 19. SECURITY CLASSIFICATION OF ABSTRACT | 20. LIMITATION OF ABSTRACT |
|---|---|---|---|
| Unclassified | Unclassified | Unclassified | Unlimited |

## Table of Contents

## Introduction

The purpose of this research was to investigate the ability of 99-Technetium Sestamibi (Tc-99-SM) to serve as a non-invasive means of assessing the presence of clinically relevant drug resistance in patients with advanced breast cancer. Tc-99-SM is a substrate of the p-glycoprotein, the transmembrane drug efflux transporter involved in classic multi-drug resistance (MDR). We proposed to the hypothesis that rapid clearance of Tc-99-SM correlates with the presence of functional MDR and can be used to predict which patients will have tumors resistant to chemotherapy drugs that are MDR substrates. We also proposed investigating whether changes in the tumor clearance of 99-Tc-SM observed before and after the administration of an MDR inhibitor, could predict whether the inhibitor can overcome clinical drug resistance in an individual patient.

## Body

***Task 1:*** *Complete a clinical trial of estramustine/paclitaxel in patients with advanced cancer of the breast refractory to paclitaxel, Months 1-30:*

- *Finalize clinical protocol. Obtain Institutional Review Board approval*
- *Recruit patients from the clinics of Bellevue and Tisch Hospital who have advanced breast cancer and are candidates for treatment with paclitaxel. Initiate treatment with paclitaxel.*
- *At the time each enrolled patient demonstrates resistance to paclitaxel, begin estramustine/paclitaxel. Patients may demonstrate primary resistance to paclitaxel (no response to an adequate trial of paclitaxel) or secondary resistance (failure following an initial response to paclitaxel).*

We encountered unexpected difficulties performing Task 1. During the process of finalizing the research protocol, new information about the interaction between the estramustine and p-glycoprotein became available. Specifically, a study of the pharmacokinetics of paclitaxel given concurrently with estramustine indicated that estramustine does not inhibit p-glycoprotein or otherwise affect drug efflux from tumor cells (1). While this clinical finding is at odds with prior laboratory studies indicating an inhibitory effect of estramustine on drug efflux (2,3), it strongly cast doubt on the ability of estramustine to serve as a clinical inhibitor of MDR. We therefore investigated the use of other agents that are more likely to successfully inhibit drug efflux and decided to replace estramustine with the biricodar dictrate (VX-710, Incel™) as the MDR inhibitor for purposes of this study. The protocol was approved by the Institutional Review Board at New York University and the Surgeon General's Human Research Review Board. Unfortunately, as final preparations were being made to enroll patients on the protocol, Vertex pharmaceuticals ceased manufacturing biricodar, and we were unable to obtain a supply of drug to go forward with the study.

We investigated other MDR inhibitors that might be used to investigate the utility of Tc-99-SM scanning as a mean of predicting clinical benefit from an MDR inhibitor in taxane-resistant breast cancer. Recent laboratory studies indicated that an important new agent, ZD1839 (Iressa) has a profound inhibitory effect on P-glycoprotein (classic MDR) and breast cancer related protein (BCRP), a drug efflux protein that may be particularly important in the development of drug resistance (personal communication, Dr. Peter Houghton). Studies in animal tumors have demonstrated that that ZD1839 is very effective at synergistic the activity of a variety of

chemotherapy drugs, including paclitaxel. Interestingly, in these experiments the enhanced anti-tumor activity achieved by adding Iressa to chemotherapy did not depend on the tumor's level of EGFR expression (4), suggesting that mechanisms other than EGFR inhibition, such MDR reversal, may be playing an important role. We revised the clinical protocol to reflect the use of ZD1839 as the MDR reversing agent in the study; however, difficulties in obtaining ZD1839 and in protocol development precluded the study from accruing patients.

***Task 2:*** *Concurrently with Task 1, complete an imaging study evaluating serial Tc-99-SM scanning to assess the presence of functional drug efflux at three critical time points in the treatment of patients during the clinical trial described in Task 1, Months 1- 30:*

- *Baseline Tc-99-SM scans will be performed before the administration of therapy with paclitaxel.*
- *At the time each patient exhibits resistance to paclitaxel, before the administration of estramustine, a second Tc-99-SM scan will be obtained.*
- *Following the administration of the first 3-day treatment with estramustine, a third Tc-99-SM scan will be obtained.*

An imaging study with Tc-99-SM scanning was approved by the Institutional Review Board at New York University and by the Surgeon General's Human Research Review Board. Under this study, we have performed Tc-99-SM scanning in 3 patients with advanced breast cancer. We carefully analyzed the Tc-99-SM clearance data, and found significant variability in the rate of clearance of Tc-99-SM from the patients'tumors. We believe that this represents varying degrees of expression of relevant drug efflux proteins (p-gp and/or MRP) in these patients. Because of the problems with obtaining an MDR inhibitor, we were unable to complete the next step in the project to determine whether ZD1839, administered in the clinical trial described in Task 1, could significantly increase tumor retention of Tc-99-SM, and whether the change in retention is reflected clinically as reversal of drug resistance to paclitaxel.

***Task 3:*** *Data analysis and report of conclusions Months 31-36:*

- *Evaluate correlations between tc-99-SM clearance, response to paclitaxel, and the efficacy of estramustine in overcoming paclitaxel resistance.*
- *A report of the conclusions and an initial manuscript will be prepared.*

Because of the difficulties with drug procurement and protocol development, there was not data to complete Task 3.

## Key Research Accomplishments

We performed preliminary studies of Tc-99-SM scanning in patients with advanced breast cancer and found variability in the clearance of Tc-99-SM suggesting that altered drug efflux may be a significant mechanism of drug resistance in some patients.

## Reportable Outcomes

There are not reportable outcomes from this work.

## Conclusions

Consistent with our hypothesis that the rate of Tc-99-SM clearance reflects the expression of drug efflux proteins, we observed significant intrapatient variation in a pilot study of tumor clearance of Tc-99-SM. We met with difficulty in obtaining an MDR inhibitor appropriate for use in the study, as other studies have cast doubt on the ability of estramustine to reverse MDR, and biricodar, our second choice of an MDR inhibitor, was discontinued by its manufacturer. Laboratory studies have shown that the agent ZD1839 (Iressa) is a potent inhibitor of P-gp and other drug efflux transporters likely to be significant mediators of drug resistance in breast cancer. We therefore rewrote the clinical protocol to reflect the use of ZD1839 as the MDR reversing agent in the study; however, difficulties in obtaining ZD1839 and in protocol development precluded the study from accruing patients.

## References


1. Garcia A, Keren-Rosenberg S, Parimoo D, Muggia F. Phase I and pharmacologic study of estramustine phosphate and short infusions of paclitaxel in women with solid tumors. J Clinical Oncology 1998; 16:2959-2963.
2. Speicher L, Barone L, Chapman A, et al. P-glycoprotein binding and modulation of the multidrug-resistant phenotype by estramustine. Journal of the National Cancer Institute 1994; 86:688-94.
3. Yang C, Shen H, Horwitz S. Modulation of the function of P-glycoprotein by estramustine. Journal of the National Cancer Institute 1994; 86:723-5.
4. Sirotnak FM. Zakowski MF. Miller VA. Scher HI. Kris MG. Efficacy of cytotoxic agents against human tumor xenografts is markedly enhanced by coadministration of ZD1839 (Iressa), an inhibitor of EGFR tyrosine kinase. *Clinical Cancer Research.* 2000;6(12):4885-92.